10.'2:30 OCA PAD INITIATION - PROJECT HEADER INFORMATION 10/31/88

Active

Project #: G-35-614 Cost share #: Rev #: 0
Center # : R6617-0A0 Center shr #: OCA file #:
Work type : RES
Contract#: 90202JRH Mod #: Document : SUBCONT
Prime #: DAAD07-86-C-0034 Contract entity: GTRC

Subprojects ? : N
Main project #:

Project unit: GEO SCI Unit code: 02.010.140
Project director(s):
PATTERSON E M JR EML-EOD (404)894-3308

Sponsor/division names: NEW MEXICO STATE UNIV / LAS CRUCES, NM
Sponsor/division codes: 400 / 050

Award period: 880916 to 890315 (performance) 890330 (reports)

Sponsor amount	New this change	Total to date
Contract value	17,000.00	17,000.00
Funded	17,000.00	17,000.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: ANALYSIS OF ULTRAVIOLET OPTICAL PROPERTIES OF ATMOSPHERIC AEROSOLS AND ...

PROJECT ADMINISTRATION DATA

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Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A N/A supplemental sheet
Equipment title vests with: Sponsor GIT
NONE PROPOSED.

Administrative comments -
THIS IS A COST-REIMBURSEMENT SUBCONTRACT UNDER AN ARMY PRIME.

12/88

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Date 8/4/89

oject No. G-35-614 Center No. R6617-0A0

oject Director E. M. Patterson, Jr. School/Lab Geo. Sci.

onsor New Mexico State University

ntract/Grant No. 90202JRH GTRC XX GIT ___

ime Contract No. DAAD07-86-C-0034

tle Analysis of Ultraviolet Optical Properties of Atmospheric Aerosols and Particulate Matter

fective Completion Date 6/15/89 (Performance) 6/15/89 (Reports)

oseout Actions Required:

___ None
___ Final Invoice or Copy of Last Invoice Already submitted
___ Final Report of Inventions and/or Subcontracts
___ Government Property Inventory & Related Certificate
___ Classified Material Certificate
___ Release and Assignment
___ Other ___

cludes Subproject No(s). ___

oproject Under Main Project No. ___

ntinues Project No. ___ Continued by Project No. ___

stribution:

___ Project Director
___ Administrative Network
___ Accounting
___ Procurement/GTRI Supply Services
___ Research Property Management
___ Research Security Services

X Reports Coordinator (OCA)
X GTRC
X Project File
X Contract Support Division (OCA)
___ Other ___

G-35-614

Analysis of Ultraviolet Optical Properties of Atmospheric Aerosols and Aerosol Particulate Matter

Final Report

(incorporating monthly Progress Reports 1-7)

for

Contract 90202JRH

Submitted to

Mr. J. M. Serna

Physical Science Laboratory
New Mexico State University
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by

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July 24, 1989

Analysis of Ultraviolet Optical Properties of Atmospheric Aerosols and Aerosol particulate Matter

Introduction

This report covers work performed by the Georgia Institute of Technology under subcontract to the Physical Science Laboratory of New Mexico State University as part of Task WAO 88-2.9-6. The goal of the work included the collection of aerosol data as a function of relative humidity to determine the optical properties of the aerosol material and the performance of UV transmission measurements to verify the proper working of an Atmospheric Sciences Laboratory Multiwavelength UV Transmissometer and to validate the ASL UV propagation model.

Accomplishments were made on each of the tasks; we were, however, required to devote a greater than expected effort to bring the UV transmissometer into operational status. Consequently our major efforts were directed toward making the transmissometer operational and evaluating instrumental performance.

The transmissometer is operational and has been used in a laboratory testing mode. An evaluation of instrument performance has been made and used to determine operational requirements for atmospheric measurements.

Instrument Description

The Atmospheric Sciences Laboratory Multiwavelength UV transmissometer was designed and constructed at the Physical Science laboratory of new Mexico State University. The instrument was designed to measure atmospheric transmission between 200 and 440 nm, with control and data acquisition functions handled by a portable computer. We extended the wavelength range to 550 nm for comparison with visibility measurements. The wavelength selection is accomplished by means of a rotating filter wheel with bandpass filters as described in Table I.

The transmissometer consists of two units, a transmitter unit and a receiver unit. The transmitter unit includes a D_2 lamp, lamp power supply, source chopper and motor, and collimating reflector. The receiver unit includes a collecting reflector, the rotating filter wheel a silicon PIN detector, and a reference chopper. Both the collimating and the collecting mirrors are 8" diameter off-axis parabaloids which are designed to provide a clear aperture for both transmit and receive optics. Auxiliary telescopes for receiver and transmitter units are provided for alignment.

The signal from the detector is measured with a lock-in amplifier and output to a computer which also provides control for the instrument. The phase and frequency reference for the lock in amplifier is provided by the reference chopper which is synchronized with the source chopper by the 60 Hz electrical power line. This provision was made to allow for remote operation of the two units with no direct physical connection required between the two units.

The computer is a HP Portable Plus. Communication between the computer and the other instrument components occurs in a two step process in which the path consists of an RS-232 port on the computer, an RS-232 to IEEE-488 GPIB conversion module, and IEEE 488 interface ports on either the amplifier or the motor control unit.

Accomplishments During Task Performance

As described in the introduction, our major efforts were directed toward making the transmissometer operational and evaluating instrumental performance. The transmissometer is operational and has been used in a laboratory testing mode. An evaluation of instrument performance has been made and used to determine operational requirements for atmospheric measurements. This work included the following specific tasks:

A. Completion of instrument control and data acquisition software

B. Development of a program combining data acquisition and instrument control functions

C. Laboratory testing of transmissometer

D. Evaluation of transmissometer, including stability

E. Development of requirements for operational use of transmissometer system

A description of each of these accomplishments follows.

A. Completion of instrument control and data acquisition software

The transmissometer is designed for automated operation. The computer, then, must control the positioning of the filter wheel at prespecified positions, change the positions of the filter wheel, initiate data acquisition by the lock-in amplifier, read the data output of the lock in, and store the data for further analysis. Initially, the filter positioning software would accept low level motor controller commands but was not set up for full automated operation. We adapted this software to automatically rotate the filter wheel. The major problem was to control speed and acceleration so that a registration of position would be maintained with no hysteresis in filter positioning and to maintain the filter alignment after many measurement cycles. The latter requirement was achieved by reversing the rotation after a complete measurement cycle instead of continued rotation in the same cycle.

The initial data acquisition software would often "lock up" or return nonsensical numbers because commands were being sent to the GPIB controller and lock-in amplifier before previously issued commands had completed. The GPIB controller and lock-in amplifier allow command status checking; and we rewrote the software to take advantage of this, solving the problems. We also added an automatic gain ranging routine to accommodate the different signal

levels associated with the different filters under different conditions. This gain ranging routine takes advantage of the capabilities of the lock-in amplifier.

B. Development of a program combining data acquisition and instrument control functions

To allow unattended operation of the instrument an overall control program was developed that included the filter wheel positioning and data acquisition programs as modules. This program has been tested, and the instrument may now be operated reliably in an unattended mode. A listing of this control and data acquisition program is included as appendix A.

C. Laboratory testing of transmissometer

Several laboratory tests of the instrument were made in an effort to evaluate the instrument's performance under carefully controlled conditions. A number of problems were found with the instrument, and all have been addressed. There was an initial problem with detector saturation at high signal levels. A neutral density filter has been added to the source for bench testing. The high signal levels suggest that the overall sensitivity of the instrument will be adequate for the desired path lengths.

A second problem was that of stability in the source lamp. Analysis of long term repetitive data at the same filter setting indicated a variation in signal of up to 20 % in lamp output energy. This problem was solved with a reduction in the output of the power supply and operation at the low intensity setting. Although the output variation is still greater than vendor specifications, the variation appears to be within acceptable levels for instrument performance.

D. Evaluation of transmissometer, including stability

Several system and instrument tests have been made. During a recent 28 hour test the system exhibited a variation of about 5%. After the first 50 minutes of the test, the variation decreased to about 3%. In any one hour period after the first hour the variation was about 1%. Tests of system response to the presence of aerosols in the path have also been made. These tests indicate that transmissions in the 90% range can be measured reliably for laboratory atmospheric paths.

E. Development of requirements for operational use of transmissometer system

The variation of system signal in a repetitive measurement situation sets some operational requirements for the use of the transmissometer in operational conditions. First the path length should be long enough so that variation in expected signal will be of the order of 10% or greater. In practice, this will require path lengths of at least 100 m. In addition, some attempt at a dual path mode is needed. Further development is needed to implement such a dual path mode.

Table I

Filter Position	Center wavelength
0	broad band neutral density
1	200
2	220
3	240
4	260
5	280
6	320
7	360
8	400
9	440
10	550
11	blocked

APPENDIX A

Transmissometer Control Program

```
10 '.....................................................................
20 'CONSTANTS-------------------------------------------------------------
30 CR$=CHR$(13):LF$=CHR$(10):ESC$=CHR$(27):NCOUNT=0:FLAG%=0:ADR%=5
40 MOTOINIT$="XA500B380H540M000S06":ADR%=5
50 '.....................................................................
60 '*****************************MAIN PROGRAM*********************************
70 '.....................................................................
80 GOSUB 990 'FLUSH I/O BUFFERS
90 GOSUB 660 'CLEAR SCREEN
100 INPUT "path\filename for data file ",DFN$
110 OPEN DFN$ FOR APPEND AS #3
120 GOSUB 660 'CLS
130 'PRINT "WAIT...":GOSUB 2040
140 PRINT "DATE IS SET TO                    "DATE$
150 INPUT "ENTER NEW DATE OR <CR> TO KEEP ";DAY$:IF DAY$="" THEN GOTO 170
160 DATE$=DAY$
170 GOSUB 660
180 PRINT "TIME IS SET TO                    "TIME$
190 INPUT "ENTER NEW TIME OR <CR> TO KEEP ";TIM$:IF TIM$="" THEN GOTO 210
200 TIME$=TIM$
210 '
220 GOSUB 660 'CLS
230 INPUT "ENTER PATH LENGTH                 ",PLEN$
240 GOSUB 660 'CLS
250 INPUT "ENTER ANY COMMENT TO 250 CHARACTERS LONG  ",COM$
260 GOSUB 660:PRINT "WAIT......" 'CLS
270 '.....................................................................
280 GOSUB 1160 'POWER ON CLEAR
290 GOSUB 1210 'DO SP
300 G$=MOTOINIT$:ADR%=5:GOSUB 530'SET UP MOTOR CONTROLLER REGISTERS
310 G$="E":GOSUB 520 'TURN OFF MOTOR CURRENT
320 GOSUB 660'CLS
330 PRINT "MOTOR WINDING CURRENT IS NOW OFF"
340 PRINT "POSITION FILTER 0 IN FRONT OF THE DETECTOR"
350 PRINT "strike any key when ready"
360 WHILE INKEY$="":WEND
370 G$="D":GOSUB 520:'TURN ON MOTOR CURRENT
380 GOSUB 660 'CLS
390 GOSUB 660 'CLS
400 INPUT "NUMBER OF SAMPLES PER FILTER ",NSAMPS
410 INPUT "INTERVAL BETWEEN SAMPLES ",SINT
```

```
440 PRINT#3,"PATH LENGTH "PLEN$
450 PRINT#3,"COMMENTS......."COM$
460 GOSUB 1930
470 PRINT#3,"filter #"NCOUNT,TIME$
480 GOSUB 1340:GOSUB 1250:GOSUB 520:PRINT#3,:GOTO 470
490 END
500 '*************************************************************************
510 '.........................................................................
520 '.........SUBROUTINE TO TALK TO MOTOR CONTROLLER
530 '
540 GOSUB 750
550 GOSUB 1210
560 IF W$(1)="0" THEN RETURN
570 IF W$(1)="65" THEN S$="@":GOTO 540
580 IF W$(1)="128" THEN S$="":GOTO 540
590 IF W$(1)="148" THEN GOTO 550
600 IF W$(1)="152" THEN GOSUB 920:GOTO 550
610 PRINT "OOPS ";:FOR J=1 TO 10: PRINT "W$("J")="W$(J);:NEXT J
620 STOP
630 '.........................................................................
640 '.........................................................................
650 '..............SUBROUTINE TO CLEAR SCREEN
660 PRINT ESC$+"H"+ESC$+"J"
670 RETURN
680 '
690 '..............WGP-610:'SUBROUTINE TO WRITE TO GP-610
700 'S$=STRING TO WRITE
710 GOSUB 990 'I/O FLUSH
720 PRINT#2,S$
730 RETURN
740 '
750 '..............WGPIB:'SUBROUTINE TO WRITE TO THE GPIB
760 'S$=STRING TO WRITE:'ADR%=GPIB ADDRESS TO WRITE IT TO
770 S$=S$+CR$+LF$
780 T$=S$    'STORE A CPY OF S$
790 'ALT GP-610 RE
800 TLST$=STR$(ADR%): GOSUB 1080 : LA$=LST$
810 S$="WRT "+LT$+" "+LA$
820 GOSUB 690
830 S$=T$: GOSUB 690
840 S$=CR$:GOSUB 690
850 RETURN
860 '
870 '..............SUBROUTINE TO READ FROM THE GP610
880 J=1:GOSUB 990
890 WHILE NOT EOF(1):INPUT#1,W$(J):J=J+1:WEND
900 RETURN
910 '
920 '..............SUBROUTINE TO READ THE GPIB
930 S$="RD 255"+STR$(ADR%)
940 GOSUB 690 'WRITE GP-610
950 GOSUB 990
960 GOSUB 870 'READ GP-610
970 RETURN
980 '
990 '..............FLUSH I/O BUFFERS
1000 CLOSE#1: CLOSE#2
1010 OPEN "COM1" FOR INPUT AS #1: OPEN "COM1" FOR OUTPUT AS #2
1020 RETURN
1030 '
1040 '..............FIND THE LENGTH OF A STRING AND REMOVE LEADING BLANKS
1050 TLST$=""'ST$=STRING TO FIND LENGTH OF. LST$=LENGTH WITH LEAD BLANKS REMOVED.
1060 TLST$=STR$(LEN(ST$))
1070 '
```

```
1090 LST$="":LTLST=LEN(TLST$)
1100 FOR I=1 TO LTLST
1110      IF NOT(MID$(TLST$,I,1)=" ") THEN LST$=LST$+MID$(TLST$,I,1)
1120 NEXT I
1130 RETURN
1140 '
1150 '
1160 '.............SUBROUTINE TO CLEAR FROM POWER ON
1170 S$="CLR":GOSUB 690
1180 S$="@":ADR%=5:GOSUB 750
1190 RETURN
1200 '
1210 '.............SUBROUTINE TO DO A SERIAL POLE OF GPIB ADDRESS 5 (GP-610 W/R)
1220 W$(1)="":S$="RSP 5":GOSUB 690:WHILE W$(1)="":GOSUB 870:WEND
1230 RETURN
1240 '
1250 '..SUBROUTINE TO STEP MOTOR TO NEXT OF TWELVE WINDOWS OR RESET TO BEGINNING
1260 ADR%=5
1270 IF NCOUNT=0 THEN FOR IK=1 TO 1200:NEXT IK
1280 IF NCOUNT=12 THEN S$="M-675":NCOUNT=0:GOTO 1300:ELSE NCOUNT=NCOUNT+1
1290 FLAG%=FLAG%+1:IF FLAG%=4 THEN FLAG%=0:S$="M575":ELSE S$="M565"
1300 ADR%=5
1310 RETURN
1320 '
1330 '-----------------------------------------------------------------------
1340 'SUBROUTINE TO COLLECT DATA---------------------------------------------
1350 GOSUB 990 'FLUSH I/O BUFFERS
1360 SINTEMP=SINT
1370 SINT=10
1380 GOSUB 1680 'wait (sint seconds) for motor noise to subside
1390 SINT=SINTEMP
1400 FOR I=1 TO NSAMPS
1410 GOSUB 1680 'TIME FOR NEXT READ ?
1420 GOSUB 1480 'do a conversion (data read)
1430 GOSUB 2090 'check signal level limits and adjust gain if needed
1440 GOSUB 1640
1450 NEXT I
1460 GOSUB 1680
1470 RETURN
1480 'do aconversion
1490 S$="CLR 4":GOSUB 1740 'CLEAR DEVICE 4 (5104)
1500 S$="WRT 4":GOSUB 1740:S$="Q1":GOSUB 1740
1510 GOSUB 1820
1520 IF W$="0" THEN GOTO 1510
1530 S$="rsp 4":GOSUB 1740:GOSUB 1780 '5104 ready ?
1540 'PRINT "rsp ",W$
1550 IF NOT(W$="128") THEN GOTO 1530  'data ready wait loop
1560 S$="RD #25 4":GOSUB 1740:GOSUB 1780
1570 P$=W$
1580 GOSUB 1880 'RS488 STATUS TO GET NUMBER OF DATA BYTES TXFRD
1590 LW$=RIGHT$(W$,1)
1600 LW=VAL(LW$)-2
1610 W$=LEFT$(P$,LW)
1620 W=VAL(W$)
1630 RETURN
1640 'print sub
1650 PRINT USING "   #####";VAL(W$);
1660 PRINT #3, USING "   #####";VAL(W$);
1670 RETURN
1680 'TIMER STUFF
1690 PT=VAL(RIGHT$(TIME$,2))
1700 AT=PT+SINT
1710 IF AT > 59 THEN AT = AT - 60
1720 WHILE NOT(VAL(RIGHT$(TIME$,2))=AT) : WEND
1730 RETURN
```

```
1750 PRINT#2,S$
1760 GOSUB 990
1770 RETURN
1780 'GP-610 READ
1790 W$="":IF NOT EOF(1) THEN INPUT#1,W$:ELSE GOTO 1790
1800 GOSUB 990
1810 RETURN
1820 'GP-610 DONE ?
1830 S$="STAT N"
1840 GOSUB 1740
1850 GOSUB 1780
1860 RETURN
1870 '5104 STTATUS
1880 S$="RSP 4"
1890 GOSUB 1740
1900 GOSUB 1780
1910 GOSUB 1820
1920 RETURN
1930 'gain?
1940 S$="WRT 4":GOSUB 1740:S$="S":GOSUB 1740
1950 GOSUB 1820:IF W$="0" THEN GOTO 1950
1960 S$="RD #25 4":GOSUB 1740:GOSUB 1780
1970 P$=W$:GOSUB 1880
1980 LW$=RIGHT$(W$,1)
1990 LW=VAL(LW$)-2
2000 W$=LEFT$(P$,LW)
2010 GN = VAL(W$) 'integer value of current gain setting
2020 PRINT#3,"GAIN SETTING #"W$
2030 RETURN
2040 'a7
2050 S$="WRT 4":GOSUB 1740:S$="A7":GOSUB 1740
2060 S$="RSP 4":GOSUB 1740:GOSUB 1780
2070 IF NOT(W$="1") THEN GOTO 2060
2080 RETURN
2090 IF (W=1999 AND GN<9) THEN GN=GN+1:GOSUB 2120:GOSUB 1480:GOTO 2090
2100 IF (W<201 AND GN>0) THEN GN=GN-1:GOSUB 2120:GOSUB 1480:GOTO 2100
2110 RETURN
2120 'adjust gain and print it.
2130 GN$=STR$(GN)
2140 S$="wrt 4":GOSUB 1740:S$="S"+GN$:PRINT S$:GOSUB 1740
2150 S$="rsp 4":GOSUB 1740:GOSUB 1780
2160 PRINT "w$ ",W$
2170 IF NOT(W$="1" OR W$="17") THEN GOTO 2150
2180 GOSUB 1930
2190 RETURN
```